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Evans

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(54) **EMERGENCY DOOR OPENING ACTUATOR**

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E05F 15/20 (2006.01)

(52) **U.S. Cl.** **49/8**; 49/4; 49/7; 49/13

(58) **Field of Classification Search** 49/1, 49/4, 7, 8, 13, 26; 52/1
See application file for complete search history.

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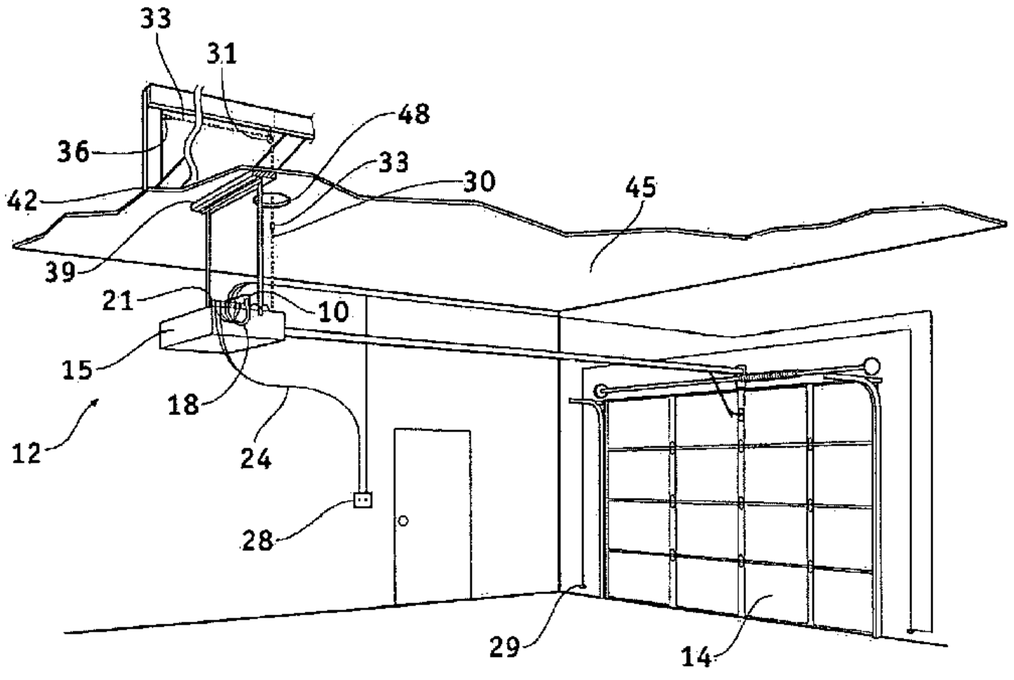
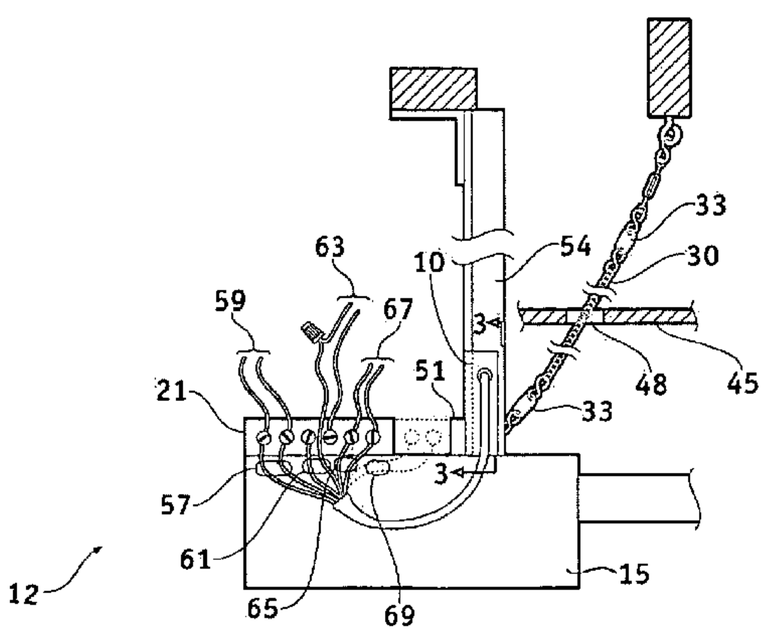
(57) **ABSTRACT**

An emergency door opening actuator includes electrical switches that are at least one of normally open and normally closed. The electrical switches may be connected accordingly in parallel or in series to terminals of an overhead door operator. The terminals may correspond to a push button circuit, an obstruction sensing circuit, an alarm system circuit, and/or a door opening circuit. The emergency door opening actuator may take advantage of a protocol in the operator to cause the overhead door to open during an emergency condition to facilitate egress. Likewise, the emergency door opening actuator may cause that the overhead door cannot close by signaling the protocol in a predetermined way when the switches are actuated by an emergency condition. The electrical switches may be mechanically actuated when at least one fusible link is broken. The emergency door opening actuator may include an automatic mechanical stop and/or a test release mechanism.

20 Claims, 8 Drawing Sheets





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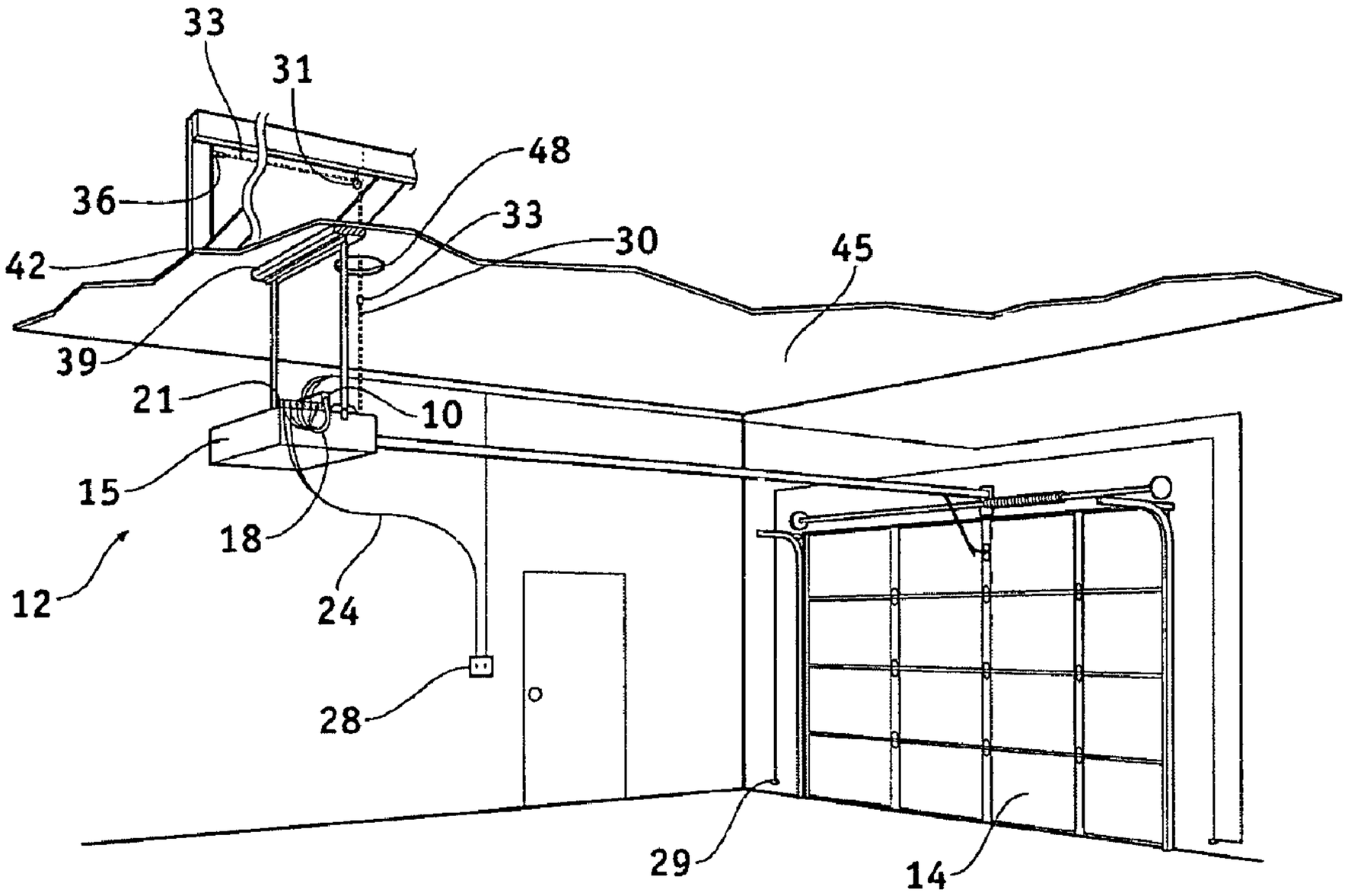
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FIG. 1

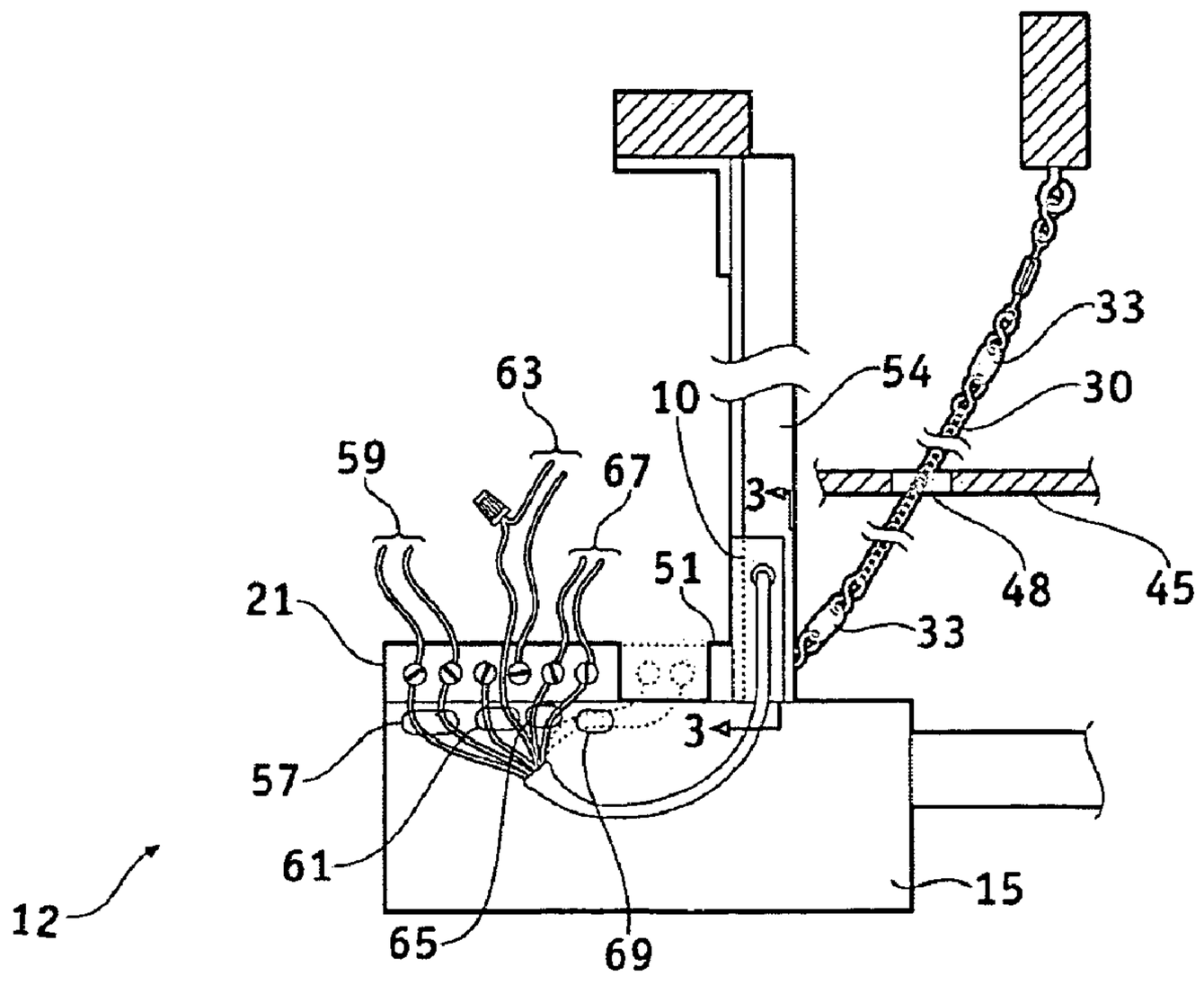
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FIG. 2

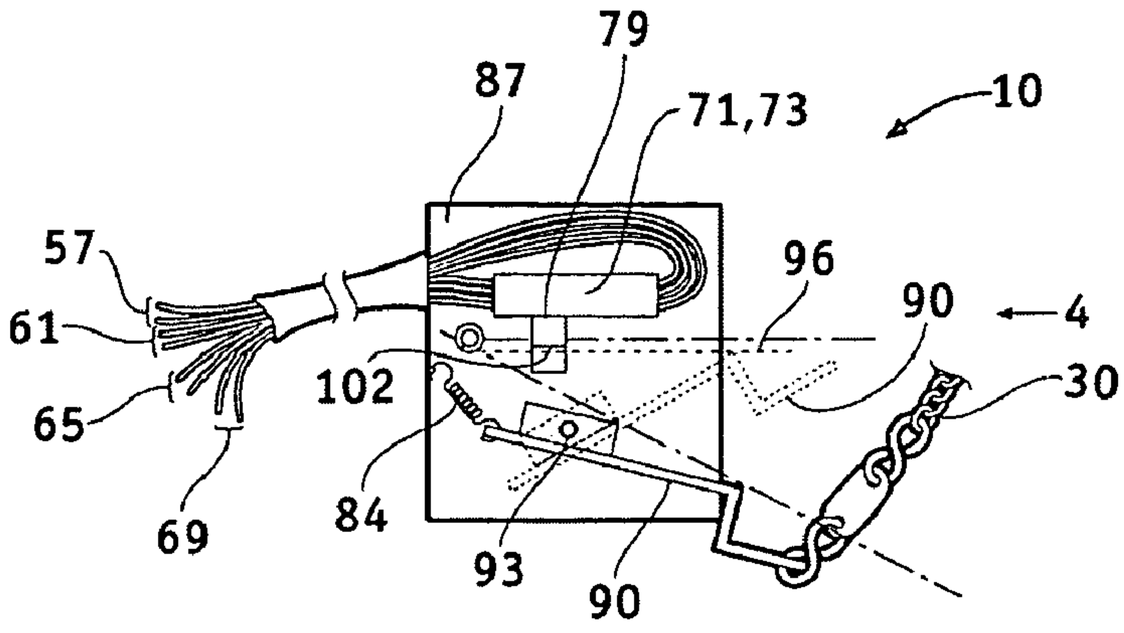

FIG. 3

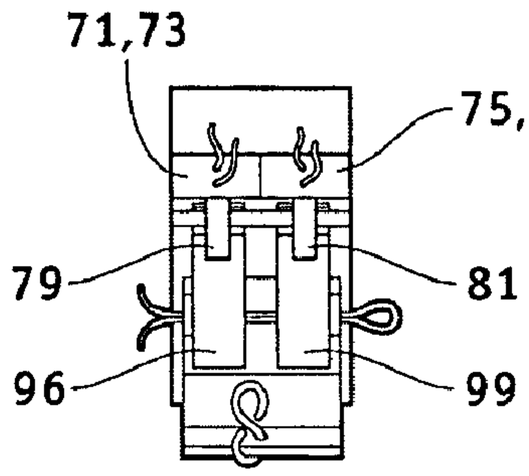

FIG. 4

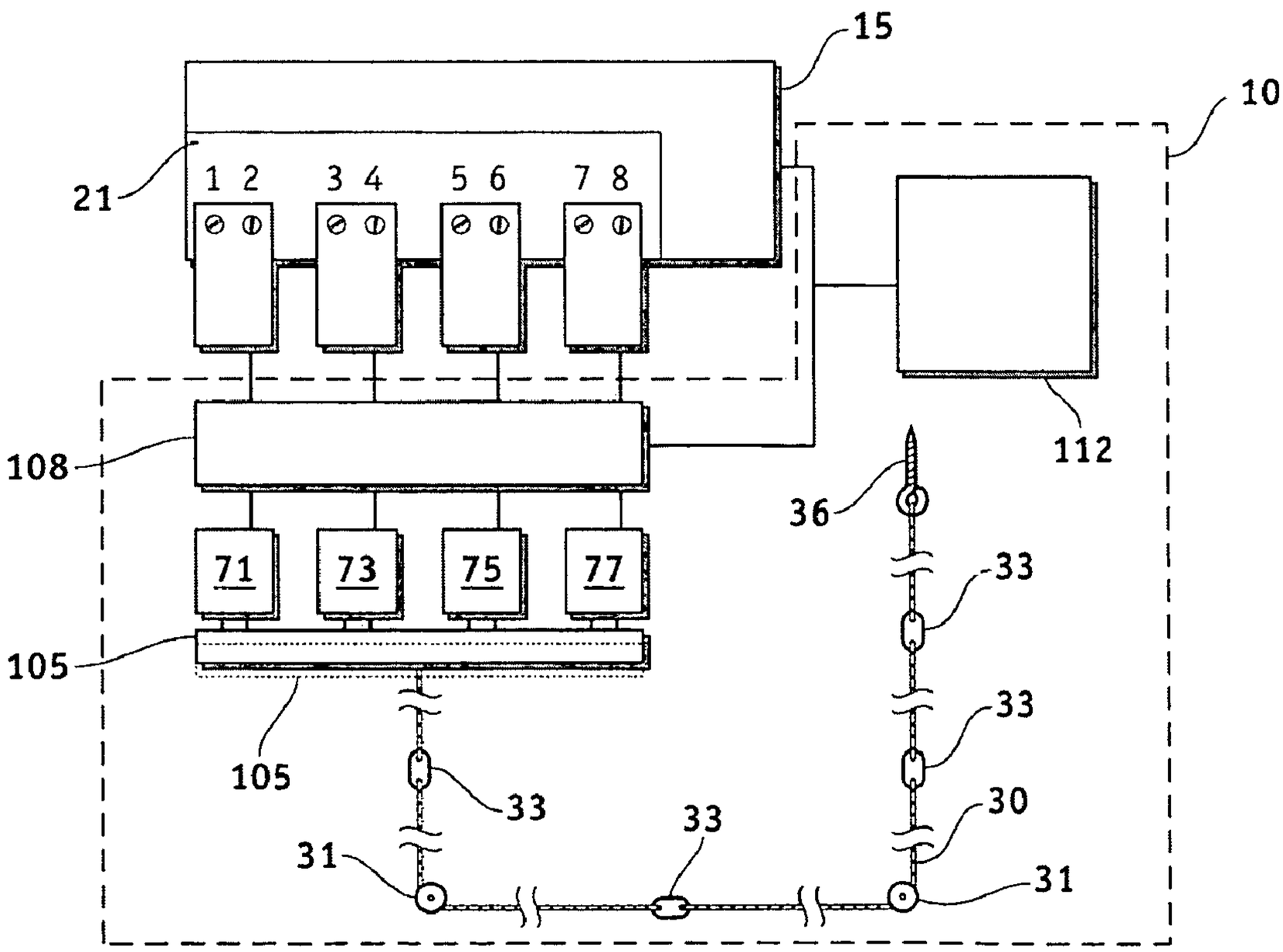

FIG. 5

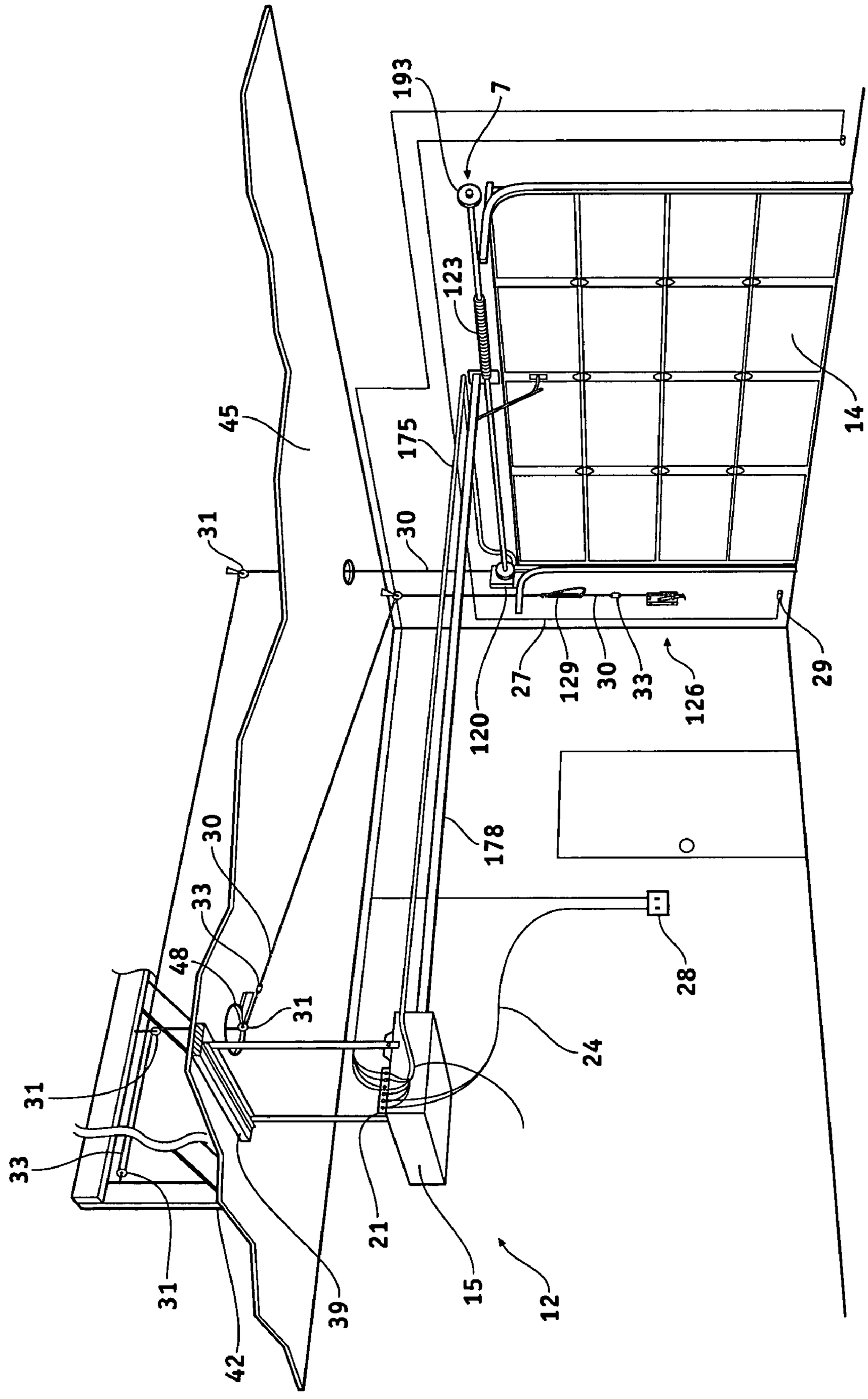
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FIG. 6

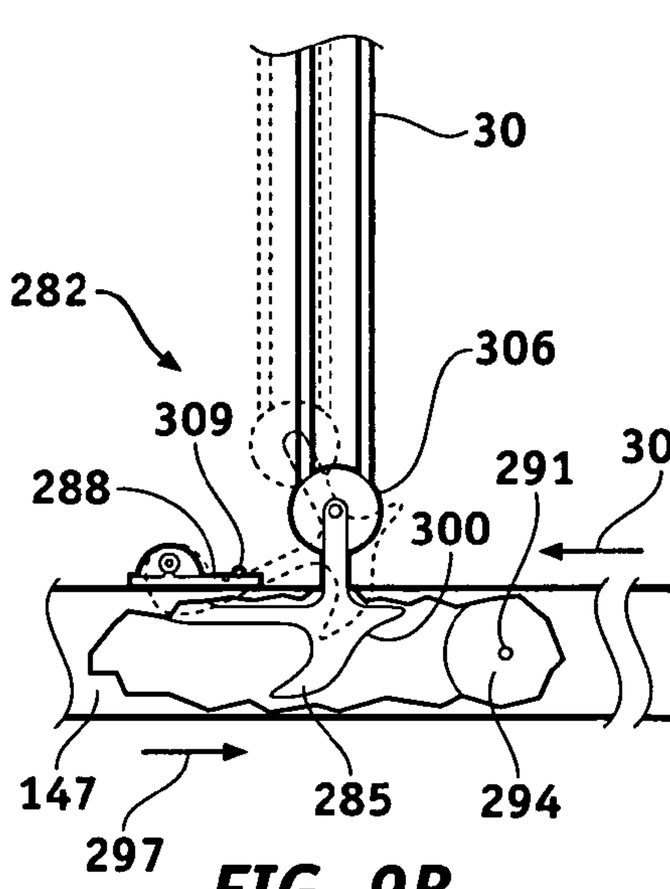
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FIG. 9B

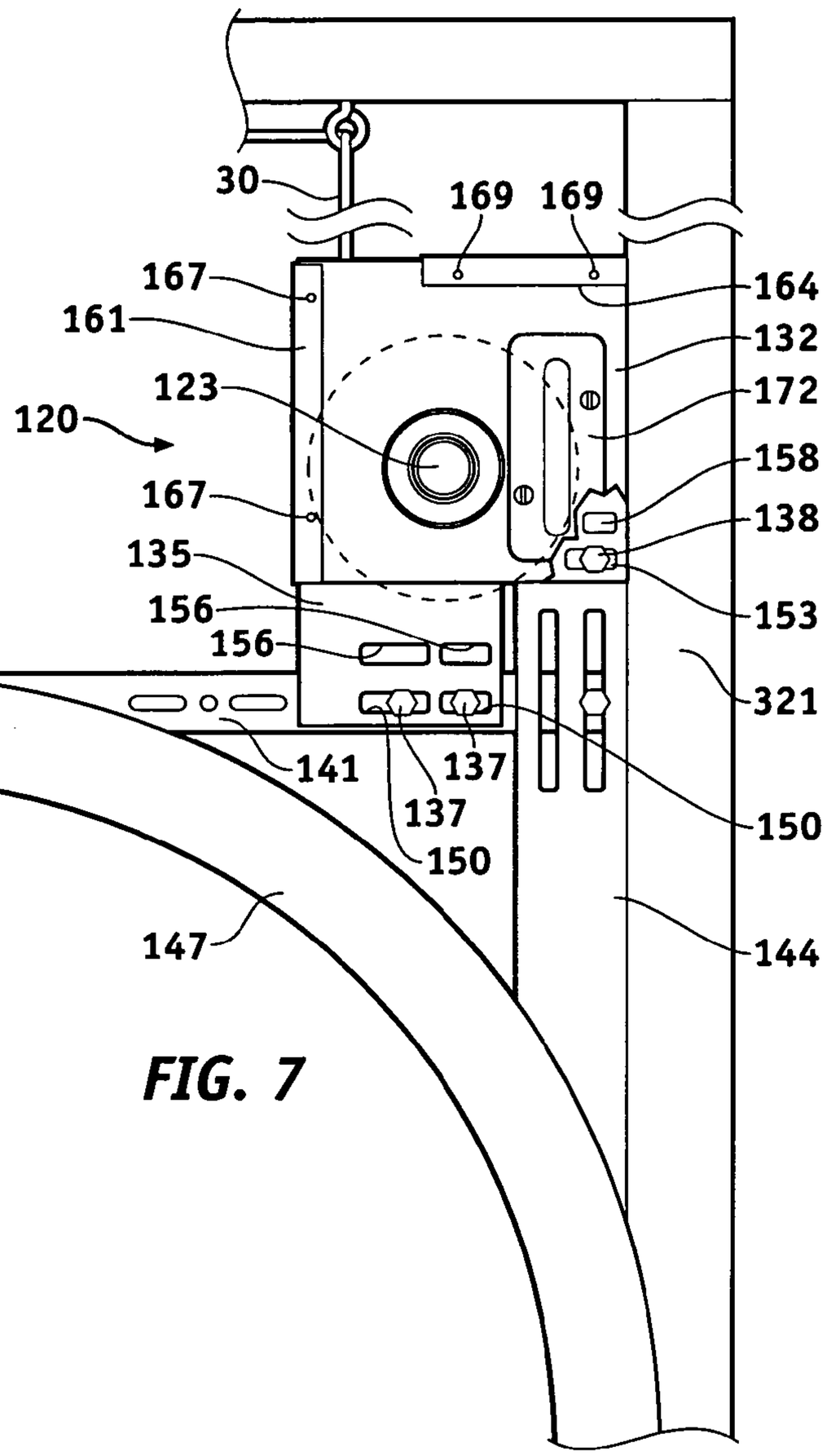
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FIG. 7

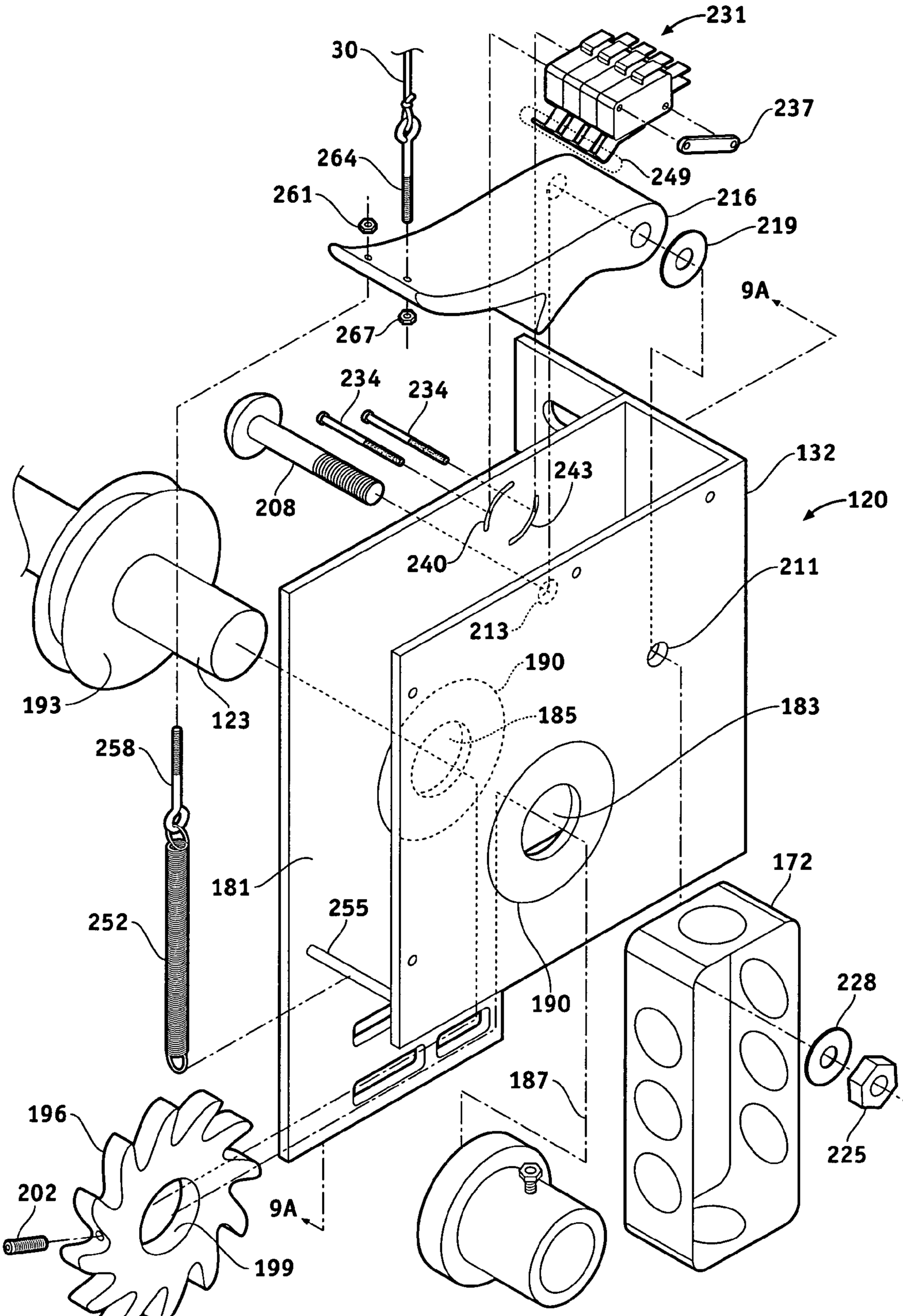
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FIG. 8

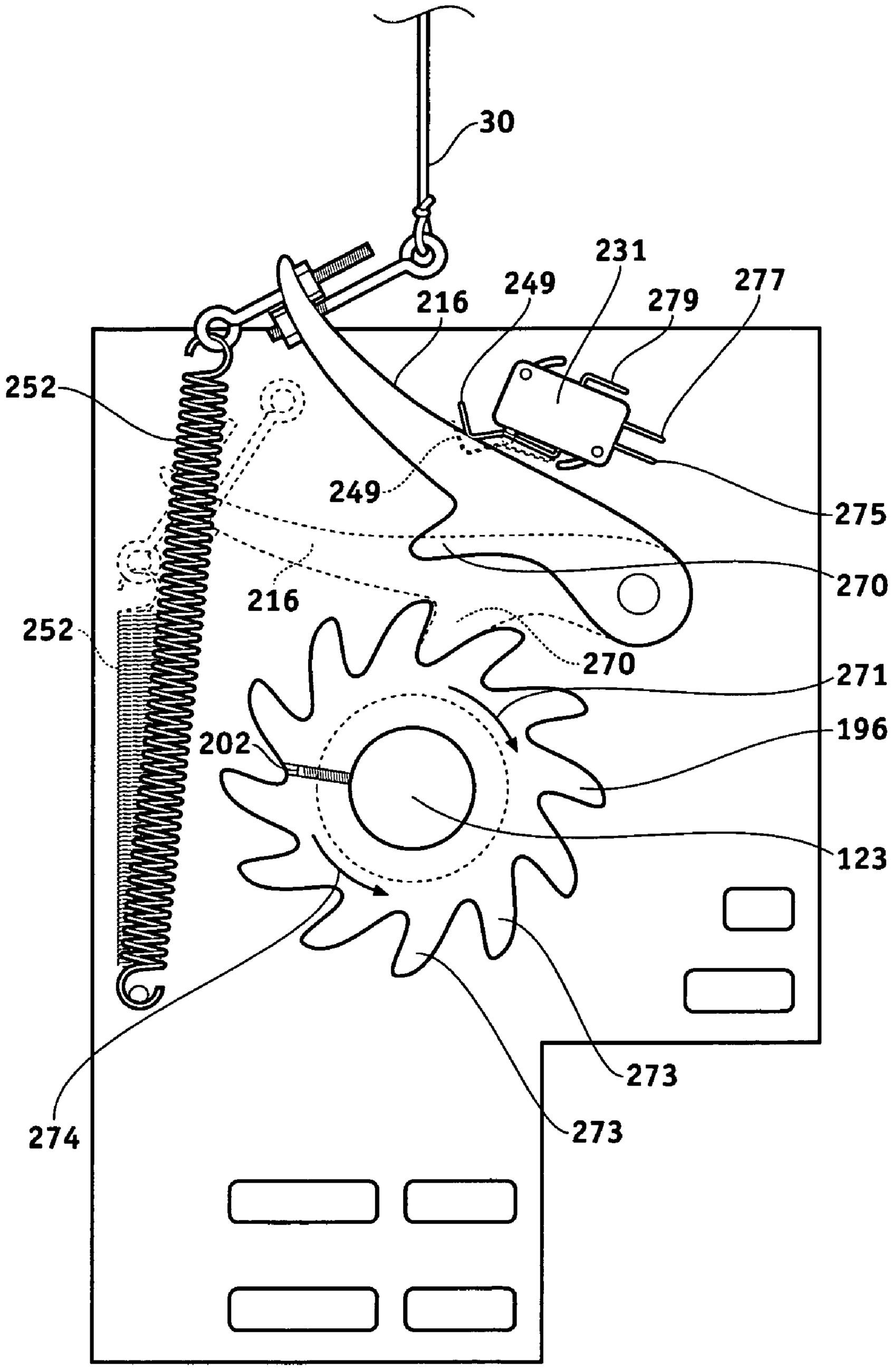
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FIG. 9A

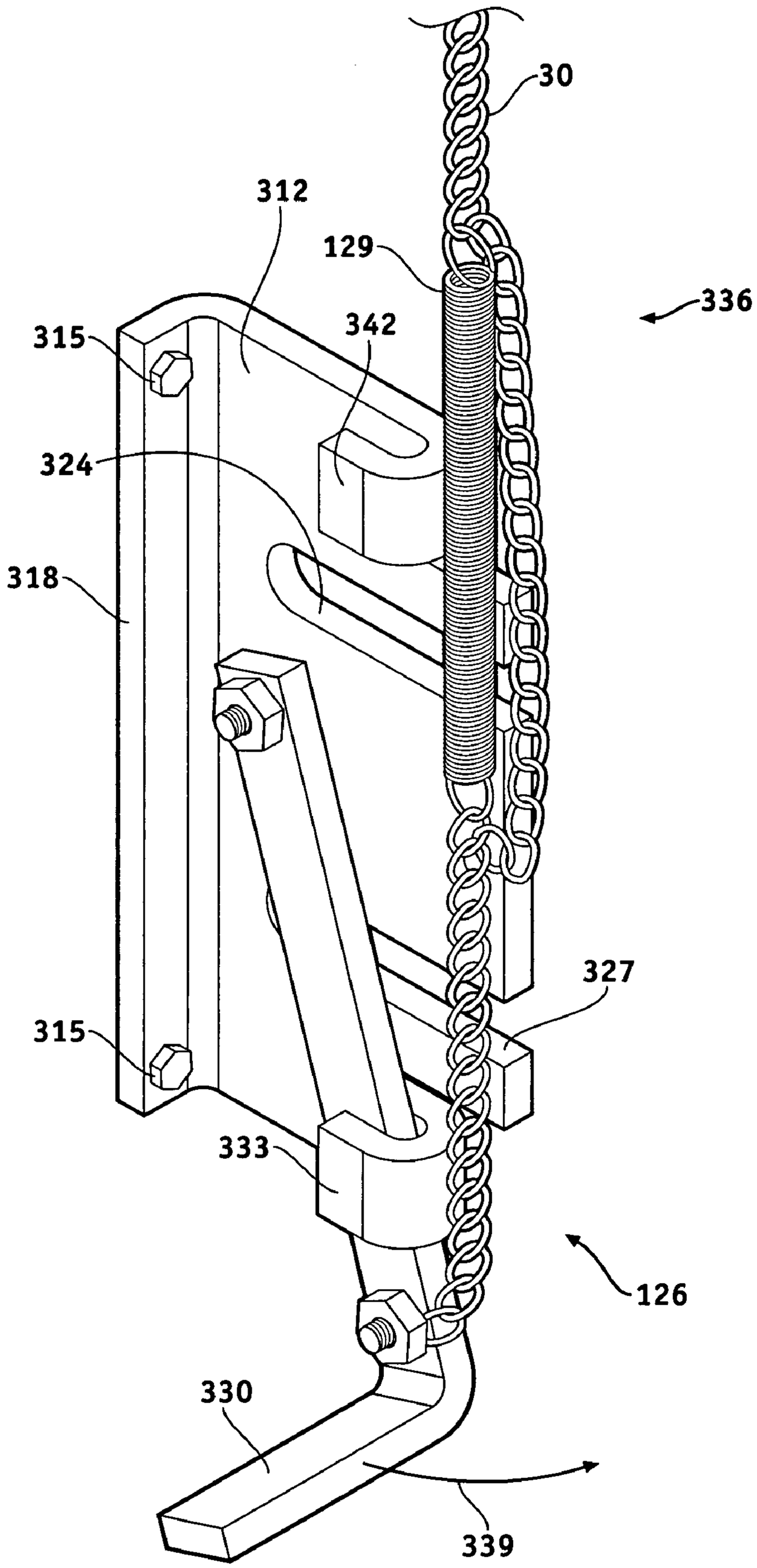


FIG. 10A

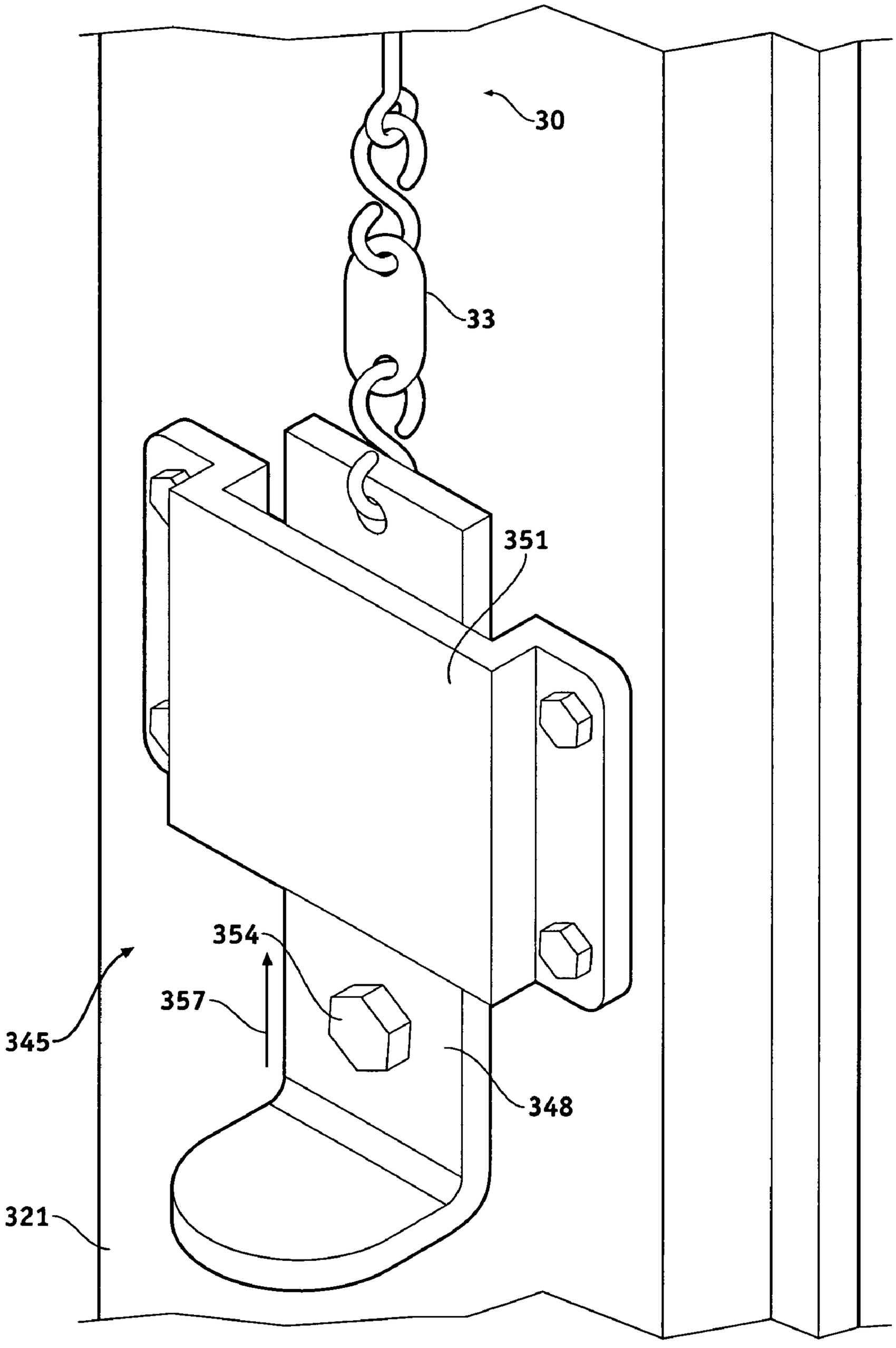


FIG. 10B

EMERGENCY DOOR OPENING ACTUATOR

This application is a continuation-in-part of U.S. patent application Ser. No. 10/964,041, filed Oct. 12, 2004, entitled EMERGENCY DOOR OPENING ACTUATOR, and a continuation-in-part of U.S. patent application Ser. No. 10/845,748, filed May 13, 2004, and entitled CONTROL SYSTEM AND TEST RELEASE DEVICE FOR AN OVERHEAD DOOR, both by the same inventor and both of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field

This invention generally relates to an emergency actuation system for overhead doors, and specifically to an emergency door opening actuator that causes an automatic overhead door to open and remain open in case of a fire or associated high temperatures.

2. State of the Art

Fire doors with actuators that cause the doors to close in emergency conditions are known. These fire door systems generally close overhead doors under the influence of gravity. Many such doors have fusible links that melt and break at temperatures above a certain range. These door systems thus have mechanical door closing actuation mechanisms and mechanical closing mechanism. Some fire doors have been developed that have electric powered door closing mechanisms and electronic door closing actuation mechanisms.

Other door systems have been developed for assuring ventilation when a high level of a toxic gas such as carbon monoxide has been detected. Once again, these door systems include electronic sensors and are actuated to open a door when a minimum level of carbon monoxide or other gas is detected.

There is a deficiency of devices for assuring egress from a garage or house through the garage door. Several persons including fire fighters have lost their lives or been severely injured by being trapped in a garage during a fire. These deaths and injuries continue to occur, indicating a need in the art for a simple, inexpensive, yet effective device that will cause an overhead door to open and allows egress in the case of a fire.

DISCLOSURE OF THE INVENTION

The present invention relates to emergency door actuation systems for overhead doors in general, and specifically to an emergency door opening actuator that causes an automatic overhead door to open in case of a fire or associated high temperatures.

An emergency door opening actuator in accordance with the present invention may include electrical switches that are at least one of normally open and normally closed. These electrical switches may be connected accordingly in parallel or in series to terminals of an overhead door operator. The terminals may correspond to a push button circuit, an obstruction sensing circuit, and/or an alarm system circuit. The operator may have an existing protocol for responding to signals from a push button circuit and an obstruction sensor circuit. Thus, the emergency door opening actuator may take advantage of the protocol to cause the overhead door to open during an emergency condition to facilitate egress. Likewise, the emergency door opening actuator may cause that the overhead door cannot close. This may be achieved by signaling the protocol in a predetermined way when the switches

are actuated by an emergency condition. The electrical switches may be mechanically actuated when at least one fusible link is broken.

In a simple form, an emergency door opening actuator may include a switch actuator movable between a first position and a second actuation position. The switch actuator may engage an electrical switch in the first position. The switch actuator may be coupled to at least one fusible link. The switch actuator may also be coupled to an anchor that is adapted for mounting to a structural member of a building/house. The anchor may take the form of a releaseable lever or test release mechanism. The releaseable lever or test release mechanism may be connected to the switch actuator. The releaseable lever may be serially connected to the switch actuator by a sash that includes the fusible link. The fusible link may be configured such that when it breaks, the switch actuator moves to its second position and actuates the electrical switch.

The emergency door opening actuator may include a mechanical stop that may form part of or be connected to the switch actuator. A door lifting shaft engaging element may be included in which the door lifting shaft engaging element is adapted to be fixed to a door lifting shaft. The door lifting shaft engaging element may be engaged by the mechanical stop when the fusible link breaks. The mechanical stop may be integral with the switch actuator.

The door lifting shaft engaging element is a toothed wheel or star gear directly engageable by a stop in the form of a pawl. On the other hand, the mechanical stop may be spaced from the door lifting shaft and may be connected to the switch actuator by a link.

The emergency door opening actuator may include a housing adapted to be mounted on a door jam to receive an end of a door lifting shaft. The housing may support the electrical switch and the switch actuator. The housing may also support one or both of a door lifting shaft engaging element and a mechanical stop.

The emergency door opening actuator may take the form of a kit that includes a housing, a door lifting shaft engaging element rotatably supportable in the housing in a centered relation on an axis of rotation in the housing, a mechanical stop supported in the housing at a position radially spaced from the axis of rotation, and a sash connectable with the mechanical stop for moving the stop between an engaged and a nonengaged state relative to the door lifting shaft engaging element.

The emergency door actuator kit may include at least one electrical switch supported in the housing. The electrical switch may be adapted for connection to an electrical overhead door operator. The kit may also include a switch actuator. The switch actuator may include the mechanical stop and an electrical switch engagement element operatively connected to the electrical switch. The emergency door actuator kit may also include a releaseable lever or test release mechanism and a mounting mechanism for mounting the test release mechanism. The sash may have a first end connectable with the mechanical stop and a second end connectable with the test release mechanism.

The fusible link may be one of a plurality of fusible links. The door opening actuator may further include a sash that includes the fusible link and couples the switch actuator to the anchor. The plurality of fusible links may be located at key locations in the building/house for release of the sash during fires or high heat in the key locations.

The emergency door opening actuator may include a housing that supports one or more of the switch, the switch actuator, and a spring. The housing may have a mounting structure

thereon adapted for attachment of the housing on a structural member proximate to an automatic door operator.

In another simple form, the present invention may include a method of causing an overhead door to automatically open during an emergency. The method may include mechanically coupling at least one electrical switch to at least one fusible link and connecting the at least one electrical switch to an automatic door operator.

Additionally, the method may include engaging the electrical switch with a switch actuator in a non-emergency state, and then moving the switch actuator and actuating the electrical switch when the fusible link is broken by an environment having a predetermined temperature.

The method may include testing a system that includes the electrical switch and the fusible link. The step of testing may include slackening a sash connected to the electrical switch. The sash may be connected to or include the fusible link. The method may include actuating a mechanical stop in response to slack in the sash and causing the mechanical stop to contact a door lifting shaft engaging element. The method may thus or otherwise include the step of inhibiting movement of the door lifting shaft engaging element in a first rotational direction. The step of inhibiting movement of the door lifting shaft engaging element may permit movement of the door lifting shaft engaging element in an opposite second rotational direction. The method may also advantageously include automatically mechanically stopping the overhead door from closing.

In another simple form, the present invention may include a method of causing an overhead door to automatically open during an emergency. The method may include mechanically coupling a switch actuator to at least one fusible link, and connecting at least one electrical switch to at least one terminal of an automatic door operator to transmit an indication to the operator similar to that which is received from a button circuit when an automatic door operator button is pressed. This aspect of the invention may also provide one or more aspects of a method of installing and/or a method of manufacturing. The method of causing the overhead door to automatically open may include engaging the electrical switch with the switch actuator in a non-emergency state. The method may also include disengaging the switch actuator from the switch and releasing the electrical switch when the fusible link is broken by a predetermined temperature. As may be appreciated, the method may include connecting a plurality of switches to a plurality of terminals in the automatic door operator to transmit indications similar to one or more of an indication that the button has been pressed, that an obstruction has been detected, that an alarm condition exists, and that the door must be raised.

The method of causing the overhead door to automatically open wherein the fusible link is integral with the sash may include anchoring a distal end of the sash to a point in a building/house, connecting a proximal end of the sash to the switch actuator, and holding the switch actuator in a non-emergency position against a bias of the switch actuator. The method of causing the overhead door to automatically open may include distributing a plurality of fusible links at selected positions on the sash for response to high temperatures at the selected positions in the building/house. In one case the method may include locating a first of the fusible links proximate the operator and locating a second of the links on an opposite side of a wall from the operator. The method may also include locating at least one of the fusible links at a remote location within the building/house.

In another simple form, the present invention may include an emergency door opening operator having an overhead door operator for raising and lowering an overhead door. A switch actuator may be movable between a first position and a second actuation position in the actuator. The switch actuator may engage an electrical switch in the first position. The switch actuator may be coupled to at least one fusible link as described above. The switch actuator may be coupled to an anchor that is adapted for mounting to a structural member of a building/house. In this way, the electrical switch may be connected to at least one terminal of the overhead door operator. Furthermore, the fusible link may be configured such that when it breaks, the switch actuator moves to its second position and releases the electrical switch.

The at least one terminal may be one of a plurality of terminals connected to a plurality of indication circuits in the overhead door operator. The electrical switch may be one of a plurality of electrical switches that are connected to the plurality of terminals of the operator. The fusible link may be configured such that when it breaks, the switch actuator moves to its second position and releases the plurality of electrical switches.

The foregoing and other features and advantages of the present invention will be apparent from the following more detailed description of the particular embodiments of the invention, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an emergency door opening actuator incorporated with an operator and overhead door system according to an embodiment of the present invention;

FIG. **2** is a side view of the operator and the emergency door opening actuator of FIG. **1**;

FIG. **3** is a sectional view of the emergency door opening actuator taken along line **3**-**3** of FIG. **2**;

FIG. **4** is an end view taken in a direction of arrow **4** of FIG. **3**;

FIG. **5** is a diagrammatic view of the emergency door opening actuator and operator configured according to an embodiment of the present invention;

FIG. **6** is a perspective view of an emergency door opening actuator operatively connected to an operator and a manual release mechanism in an overhead door system according to an embodiment of the present invention;

FIG. **7** is a side view of the emergency door opening actuator of FIG. **6**;

FIG. **8** is an exploded view of the emergency door opening actuator of FIGS. **6**, and **7**;

FIG. **9**A is a diagrammatic sectional view taken along lines **9**A-**9**A of FIG. **8** of the emergency door opening actuator in an assembled state;

FIG. **9**B is a side view of a stop mechanism that may be connected with any emergency door opening actuator such as that shown in FIG. **1** or FIG. **6** in accordance with an alternative embodiment of the invention;

FIG. **10**A is a perspective view of a releaseable lever and mounting mechanism; and

FIG. **10**B is a perspective view of a releaseable lever and mounting mechanism in accordance with an alternative embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

As discussed above, embodiments of the present invention relate to emergency actuation systems for overhead doors in

general, and specifically to an emergency door opening actuator that causes a door to open in case of a fire or associated high temperatures.

FIG. **1** shows an emergency door opening actuator **10** incorporated with an automatic door opening system **12** for causing a door **14** to be opened in case of a fire. The door opening actuator **10** may be mounted to an operator **15** of the automatic door opening system **12** or to proximal structural members that are part of or connected to a building in which the door opening actuator is to be used. It is to be understood that references to building herein include residential homes.

As shown, at least one line **18** may extend from the door opening actuator **10** and be connected to a terminal strip **21** to which the push button circuit **24** and the obstruction circuit **27** may also be connected. As may be appreciated, the push button circuit **24** connects the operator **15** to the push button **28** that may be pressed by a user of the automatic overhead door system **12** in a conventional manner. Furthermore, the obstruction circuit **27** includes an optical sensor **29** for detection of an obstruction in a conventional manner. The connections of the line **18** to the terminal **21** may be advantageously made to effectuate the functions of the present invention as will be described in greater detail below.

A sash **30** may couple the door opening operator **10** to one or more fusible links **33** that help make up the sash **30**. The sash **30** is also for the purpose of coupling the door opening actuator **21** to an anchor **36**. It is to be understood that the sash **30** may be any one of a number of flexible elements such as, rope, wire, cable, or chain. The sash **30** may include rigid linkages that may be formed of rods, channel members, bars, posts, or levers. The sash may also include one or more tension adjusting mechanisms and removable links. The sash may include any combination of the above described elements.

The operator **15** and the door opening actuator **10** may be suspended from exposed rafters **39**, or rafters **42** enclosed behind a drywall ceiling **45** in a known manner. The sash **30** may be extended through an opening **48** in the drywall ceiling. Furthermore, the sash **30** may be extended through any number of walls throughout the building and may be routed around corners by rollers **31** or eye bolts to enable selective placement of additional fusible links **33** at any location throughout the building. Thus, the sash **30** will be released when a fire or associated high temperatures are experienced at any of the locations.

FIG. **2** is a side view of the operator **15** and door opening actuator **10** of FIG. **1**. As shown, the operator may have a mounting flange **51** fastened to one or more suspension member **54**, or may be mounted in any conventional manner. The door opening actuator **10** may also be mounted to the mounting flange **51**. The door opening actuator **10** may be at least partially supported in an attractive housing that may be powder coated with a fire resistant paint. The door opening actuator **10** may thus become substantially integral with the operator **15** and the overall door opening system **12**. In fact, the door opening actuator may be incorporated directly within the operator housing and may be made part of an operator by a manufacturer. This is due, in part, to the door opening actuator's complete compatibility with the operators available on the market today.

The terminal strip **21** may be exposed or may be enclosed in the operator **15**. Thus, the terminal strip **21** is shown in a manner that may be considered schematic in FIG. **2**. The line **18** may include a sheath that encloses a plurality of wire pairs that may be connected to the terminals of the terminal strip **21**. A first pair of wires **57** may be connected in series to a pair of wires **59** forming the push button circuit **24** when the push button circuit is a normally closed circuit. (A series connection with the obstruction sensor circuit **27** is shown in FIG. **2**.) Alternatively, the first pair of wires **57** may be connected in parallel to a pair of wires **59** forming the push button circuit **24** as shown by connections at the two left most terminals in FIG. **2** when the push button circuit **24** normally operates as an open circuit. A second pair of wires **61** may be connected in series with a pair of wires **63** forming the obstruction sensor circuit **27** since the obstruction sensor circuit **27** normally operates as a closed circuit. It is to be understood that series or parallel connections may be applied depending on whether the circuit to which the respective switches are to be connected normally operate as closed or opened circuits. As such, a third pair of wires **65** may be connected in series or parallel with a pair of wires **67** forming an alarm circuit. Another pair of wires **69** may be provided in additional to or in substitution of the other pairs. The pair of wires **69** may be connected to terminals that are connected to logic and/or protocol configured specifically for preferentially sending a door **14** open in the case of an emergency. This logic and/or protocol may be provided in the operator by the manufacturer similar to the protocols for each of the other circuits to which the other terminals are connected. That is, the terminals shown in dashed lines in FIG. **2** may be a pair of terminals dedicated to the safety function of the present invention. Thus, in the event that a manufacturer wishes to implement the advantages of the present invention directly into a particular operator, doing so may be accomplished by including the door opening protocol and an internal or external connection analogous to the terminals shown in dashed lines for connection to wires analogous to wires **69** connected to a door opening actuator. This may be done in addition to (for redundancy), or in place of the rest of a door opening actuator analogous to door opening actuator **10** that is to be connected to the other terminals and to the other circuits including the push button circuit **24** and the obstruction sensor circuit **27**.

The pairs of wires **57**, **61**, **65**, and **69** are connected to respective electrical switches **71**, **73**, **75**, and **77** shown in FIGS. **3-5**. The switches may have two switches housed together as shown in FIGS. **3** and **4**. In this case, pressing button **79** actuates both switches **71** and **73** simultaneously. Pressing button **81** may actuate both switches **75** and **77** simultaneously. As shown, a spring **84** may be secured to a housing **87** and to a switch actuator **90** for biasing the switch actuator toward a position in which it does not engage the buttons **79** and **81**. On the other hand, the switch actuator could take any of a number of forms and may be moved into its non engaging condition by any of a variety of biasing mechanisms including under the force of gravity. While FIGS. **3** and **4** depict the switch actuator as including an actuation lever **90** that is pivoted on a pin **93**, the switch actuator may alternatively take the form of a plunger or other movable mechanism that is capable of moving between two positions. FIGS. **3** and **4** also show intermediate spring levers **96** and **99** that are moved by the actuation lever **90** and engage the buttons **79** and **81** in a resilient manner. These spring levers **96** and **99** thus have the advantage of protecting the switches **71**, **73**, **75**, and **77** against forces from a rigid switch actuator that may be too great and cause damage. As may be appreciated, the actuation lever **90** and the spring levers **96** and **99** of the exemplary embodiment of FIGS. **3** and **4** works in concert and together provide the switch actuator.

During installation of the door opening actuator **10**, the sash **90** must be pulled so that the actuator lever **90** is in a first position indicated by the actuation lever **90** shown in dashed lines in FIG. **3**. The sash is anchored and tensioned as desired.

The spring levers **96**, **99** in this position resiliently press the buttons **79** and **81** into their depressed position shown at **102**.

In one example, the switch **71** is normally closed when not pressed. However, in the embodiment of FIGS. **3** and **4**, the initial position for operation of the door opening actuator **10** is with the button **71** pressed. Thus, during use, switch **71** is held in the open position.

Therefore, when a fusible link breaks, the actuation lever is released and is biased into its normally closed position. Button **79** is disengaged by the actuation lever **90** and the spring lever **96** so that the first switch **71** moves into its closed condition. As may be appreciated, the series connection of the first pair of wires **57** from the first switch **71** to the first pair of terminals and the push button circuit **24** will actuate door **14** as though the push button **28** had been pressed when the circuit **24** is a normally closed circuit. Alternatively, a parallel connection of first pair of wires **57** from the first switch **71** to the first pair of terminals and the push button circuit **24** will actuate the door **14** as though the push button **28** had been pressed when the circuit **24** is a normally open circuit. Thus, if the door **14** is originally closed when a fusible link breaks, the door **14** will be caused to go up by the closure of switch **71** under the same protocol as for operation of the door by the push button **28**. At the same time, the second switch **73** is normally open when the button is not engaged so that during operation with the button **79** pressed, the second switch is held closed. When the fusible link breaks, the actuation lever **90** is released and the second switch is moved to the open condition. This may send a signal to the operator akin to that received when an obstruction is detected by the sensor **29**. Since the door **14** is closed or already going up, the protocol may do nothing to change the action by the operator as under similar conditions with an obstruction detected by the sensor **29**. Alternatively, the protocol may completely interrupt wiring to the sensor to prevent the door from closing.

As shown in FIG. **2**, the second switch **73** may be connected in series by the second pair of wires **61** from the door opening actuator **10** with the pair of wires from the obstruction circuit **27**. This is advantageous because the obstruction circuit operates as a normally closed circuit and is opened when an obstruction is detected. Therefore, holding the second switch **73** in the closed condition absent a fire enables the second switch to function properly when placed in series with the obstruction circuit. In this configuration, it can be appreciated that as soon as a fusible link is broken, the emergency door opening actuator will open the circuit formed in series with the obstruction sensing circuit **27** and the door **14** cannot close.

In the case of the door **14** being already open, actuation of the door opening actuator **10** when a fusible link breaks will cause the first switch to close, which will start closing the door. However, the second switch will be opened causing the door **14** to either stop of reverse and go up in accordance with the protocol in the operator **15** for the case in which the door **14** is descending and an obstruction is sensed. Similarly, if the door **14** is stopped between a completely opened and a completely closed condition, then either the first switch will send the door **14** up or the second switch will send the door up in accordance with the existing protocols in the operator **15**. Once again, with the series circuit formed with the obstruction sensing circuit open, the door **14** cannot close.

The third switch **75** may be connected to the fifth and sixth terminals by the third set of wires **65** in systems **12** that have a protocol for connection with an alarm system within the building. Depending on whether the configuration of the alarm system operates as normally closed or normally opened, the third set of wires **65** may be connected in series as shown or in parallel. The third pair of wires **65** may thus send a signal that actuates the alarm system when a fusible link breaks and the switch actuator is released. Alternatively or additionally, the third switch or an additional switch may be connected directly to an audio and/or visual indicator or alarm associated with the actuator(s) (and release device to be described below).

The fourth switch **77** may be connected to a seventh and eighth terminal by a fourth pair of wires **69** as a fail safe measure for sending the door **14** up if the first and second switches **71** and **73** fail to cause the door **14** to go up, in a case of a burned switch or wires. Alternatively, the fourth switch may replace the function described above with regard to the first and second switches **71** and **73** by causing the door **14** to go up when a fusible link breaks and the fourth switch is actuated. A protocol may be provided in the operator to respond to such a signal and preferentially open the door **14** under such emergency conditions.

It is to be understood that while a specific example has been shown and described herein, the same function may be achieved by a different combination of parallel and/or series connections without departing from the spirit and scope of the invention. For example if the push button circuit **24** were to operate in a normally closed condition so that opening the circuit **24** actuates the door **14**, then a parallel connection of the first pair of wires would have to be replaced by a series connection. Similarly, the switches need not be initially held in a condition opposite from their at rest condition. The circuitry may be adjusted to accommodate such modifications.

FIG. **5** is a diagrammatic view of the operator **15** and the door opening actuator **10**. As shown, the terminal strip **21** may include first through eighth terminals, which may be connected to the first through the fourth switches **71**, **73**, **75**, and **77**. In this diagram, the switches are shown as separately housed switches that have respective buttons. A switch actuator **105** may be moved between an engaging and a non-engaging position as shown in solid and dashed lines. This switch actuator **105** may be a combination of levers **90**, **96**, and **99**, or may be a single member. The switch actuator **105** may be coupled to one or more fusible links **33**. The switch actuator may also be coupled by the sash **30** to the anchor **36** for engagement in a structural member of the building in which the door opening actuator is to be installed.

As indicated by the plurality of fusible links **33** and the plurality of guide rollers **31**, the sash may be routed to any location within the building, and may be used to selectively distribute fusible links throughout the building. For example, a first fusible link **33** may be located proximate to the operator **15**. A second fusible link may be located on an opposite side of a wall such as the drywall ceiling **45** for response to a fire or associated heat that may be temporarily isolated to a volume within the attic. Other locations in the attic may be monitored similarly by a long sash that may extend to remote positions in the attic as shown in FIG. **1**. Thus, if any of the fusible links breaks, then the door opening actuator will be actuated and will in turn cause the operator **15** to raise the associated overhead door **14**. In some applications, the sash may be connected to a plurality of doors. For example, the sash may interconnect multiple doors of a distribution dock facility so that one or more doors is actuated when the sash is slackened.

FIG. **5** also include a timing device **108** that may be operably connected to the switches **71**, **73**, **75**, and **77**. This timing device may be desirable in some circumstances in order to delay the opening of the door **14**. For example, the timing device could delay causing actuation of the door for approximately five to ten minutes so that the fire may be isolated for the short period of time between notification of the fire department and their arrival. This may be beneficial for buildings that have an alarm system that automatically notifies the fire department. However, the safety issues of a need for egress will usually override any advantage that a timing device may provide.

The door raising actuator **10** may also include a backup power supply **112** that may be connected to the operator and/or time delay device **108**. The battery backup may include one or more batteries and may have sufficient power to raise the door completely and actuate any alarms.

FIG. **6** is a perspective view similar to FIG. **1** with a door opening actuator **120** mounted at a location that is separate from the operator **15**. The door opening actuator **120** in this case may be mounted on structural members near one side edge of the overhead door **14**, and may receive an end of a spring shaft **123** therethrough. Housings for the door opening actuator may be configured for selectively mounting on either end of the spring shaft **123**.

The door opening actuator **120** has a housing configured for receipt on a left end of the spring shaft as viewed in FIG. **6**. A mirror image of the housing of the door opening actuator **120** is shown in FIGS. **7**, **8**, and **9**A. The housing of FIGS. **7**, **8**, and **9**A is for mounting the door opening actuator on an opposite end of the spring shaft **123**, as may be appreciated.

A sash **30** may connect the door opening actuator **120** with a test release mechanism **126**. The sash **30** may be of any desired length, and may include any number of fusible links **33** that may be selectively placed throughout the building in which the overhead door **14** is installed. As shown, the sash **30** may be tensioned over a multitude of rollers **31** or other guides so that when tension is released in the sash **30**, switches in the door opening actuator **120** may be released as will be described in greater detail below. As shown in FIG. **6**, a tensioning spring **129** may be provided at one or more positions along a length of the sash **30** to allow for tolerancing and provide constant tensioning when the sash is not released.

In FIG. **7**, the door opening actuator **120** is shown as it would appear when mounted on a right most end of the spring shaft **123** as viewed in a direction of arrow **7** in FIG. **6**. The door opening actuator **120** has a housing **132** that may be mounted by an integral downwardly extending plate **135** and a plurality of fastening members **137** and **138** to existing structural members **141** and **144** that regularly hold the overhead door track or roller guide **147** in place, as shown.

When supported on the existing structural members **141** and **144**, the housing **132** may be configured to receive the spring shaft **123** therethrough. The fasteners **137** and **138** may be received in lower slots **150** and **153**. Upper slots **156** and **158** enable vertical adjustment of the door opening actuator **120**. The elongate structure of the slots **150**, **153**, **156**, and **158** enable adjustment of the mounting position of the housing **132** in a horizontal direction.

The housing **132** may have a vertical cover **161** and a horizontal cover **164** for enabling easy access to an interior of the housing **132**. To this end, respective screws **167** and **169** may secure the covers **161** and **164** in covering relation on the housing **132** during regular operation. A junction box **172** may receive a line **175** containing a set of wires generally analogous to the wires of line **18** in FIG. **1**. The line **175** is shown in FIG. **6** extending from the same terminals of the operator **15** as the wires of line **18** in FIG. **1**. However, as shown in FIG. **6**, the line **175** may be extended along an overhead door track **178** to a wall above the overhead door **14**, and may be run along the wall to the door opening actuator **120**. The junction box **172** shown in FIG. **7** may include removable slugs for selectively directing the line **175** into an interior of the housing **132**. The junction box **172** may also have a conventional clamping mechanism for securing the line **175** to the housing near the end of the line **175** that is to be attached to switches in the interior of the housing **132**.

FIG. **8** is an exploded view of the door opening actuator **120** of FIG. **7** and shows the interior **181** and various components that are received therein in an assembled state. Front and rear openings **183**, **185** are centered on a common axis **187** and are adapted to receive the spring shaft **123** therethrough. Bearings **190** may be provided in the openings **183**, **185** to enable uninhibited rotation of the spring shaft **123** within the housing **132** during regular operation.

As may be appreciated, the door opening actuator **120** may be installed on the spring shaft **123** with the housing **132** abutted against an outwardly facing surface of a cable drum **193**. During installation, a star gear **196** may be inserted into the interior **181** of the housing **132** and centered on the axis **187**. Thus positioned, the star gear **196** may receive the spring shaft **123** through a center hole **199** of the star gear **196**. In this way, the star gear **196** is a shaft engaging element and may be fixed to the shaft by a set screw **202**. Once fixed to the spring shaft **123**, the star gear **196** will rotate together with the spring shaft **123** during regular operation. A shaft collar **205** may be fixed to an outer end of the spring shaft **123** adjacent to an outer surface of the housing **132** to inhibit relative axial movement between the housing **132** and the spring shaft **123**.

In order to support another component within the housing **132**, a bolt **208** may extend through front and rear pawl lever mounting apertures **211**, **213**. The bolt **208** may rotatably mount the pawl lever **216** within the housing **132**. The pawl lever **216** may have a through opening **219** for receiving the bolt **208** therethrough. A spacer **222** may help position the pawl lever **216** on the bolt **208**. A threaded end of the bolt **208** may be received through the front aperture **211** and may be secured by a nut **225** and washer **228**. Thus, the bolt **208** may provide an axle on which the pawl lever **216** may rotate. As shown in the embodiment of FIG. **8**, the bolt **208**, the nut **225**, and the washer **228** may also hold the junction box **172** in place on an outer surface of the housing **132**.

A set of micro switches **231** may be secured in an interior of the housing **132** by screws **234** that may extend through the micro switches **231** and threadedly engage a plate **237**. The screws **234** may extend through holes **240** and **243** in the rear wall of the housing **132**. Either one or both of the holes **240** and **243** may be arcuately configured to enable angular adjustment of the set of micro switches **231** within the housing **132**. Each micro switch of the set **231** may have a button **246** engaged with and depressable by respective limit arms **249**. These limit arms **249** are pivotally connected to the micro switches **231** at first ends thereof and extend outwardly away from the micro switch for engagement by a mechanical member. In this case, the mechanical member may be provided by the pawl lever **216**.

The pawl lever may be biased toward an engaged position by a spring **252**. The spring **252** may be connected at a first end to a pin **155** fixed to the housing **132** and an eye bolt **258** that may be secured to the pawl lever **216** by a nut **261**. The sash **30** shown and described in FIG. **6** may extend into the interior **181** of the housing **132** and be secured to the pawl lever **216** by an eye bolt **264** and a nut **267**. Thus, when the sash **30** is tensioned for regular operation of the system, the pawl lever **216** is pulled against the bias of the spring **252** into a non-engaging position in which a pawl **270** of the pawl lever **216** is held in spaced relation relative to the star gear **196**.

FIG. **9**A is a diagrammatic sectional view taken generally along the lines **9**A-**9**A of FIG. **8** clearly depicting the relative positions of the pawl lever **216**, the spring **252**, the limit arms **249**, and the star gear **196**. As shown, when tension is released on the sash **30** in an emergency or test situation, the spring **252** is released from a position shown in solid lines and moves to a contracted state shown in dashed lines. Likewise, the pawl lever **216** moves from a position indicated in solid lines to a position shown in dashed lines. The integral pawl **270** on the pawl lever **216** likewise moves into the position indicated by dashed lines and engages the star gear **196**. Since the star gear is fixed to the spring shaft **123** by the set screw **202**, the spring shaft **123** is inhibited from movement in the clockwise direc-

tion **271** as viewed in FIG. **9**A when the pawl lever has been released such as in an emergency or test situation, for example.

In a practical application, this locking engagement of the pawl with the star gear **196** may prevent an overhead door from closing during an emergency such as a fire. On the other hand, an angle of the pawl **270** relative to the splines **273** on the star gear and the resilient releaseability of the pawl lever **216** due to the resilient flexibility of the spring **252**, the star gear and the spring shaft **123** are free to move in the counterclockwise direction **274** even though the pawl lever **216** is released and urged to the position shown in dashed lines. Thus, the star gear **196** and spring shaft **123** may allow the door **14** to go up under control of the operator **15**, and an advantageous safety mechanism may be provided in which the overhead door **14** is permitted to open but is prevented from closing.

Similar to the spring levers **96** and **99** in the embodiments shown and described with regard to FIGS. **1-5**, the limit arms **249** transfer sufficient forces and reduce harmful forces. That is, the limit arms **249** are somewhat flexible so that excessive forces applied by the pawl lever **216** to the limit arms **249** will simply bend the limit arms **249** and not damage the micro switches **231** and their respective buttons **246**. The micro switches **231** have respective first, second, and third electrical leads **275**, **277**, and **279**. A pair of these leads **275**, **277**, and **279** may be connected similarly to the connections of pairs of wires to the switches **71**, **73** shown and described with regard to FIGS. **2-5**. A first lead may provide a normally open circuit, a second lead may provide a normally closed circuit, and a third lead may provide a common for either of the first and second leads. The micro switches **231** may be connected to the operator **15** in the same way via the set of wires within the line **175** so that the door may be caused to open in an emergency or test situation under operator control in accordance with the same method described above. With separate respective buttons **246**, the switches set of wires within the line **175** may be connected to the leads **275**, **277**, and **279** so that all the wires in line **175** may be connected to the terminal **21** in series. Thus, installation can be simplified.

The embodiments shown in FIGS. **6-9**A have the advantage of an additional mechanism, which is mechanical, that provides redundancy for preventing an overhead door from closing in an emergency for a test situation. This redundancy, especially since it includes a mechanical fail safe stop, is exceedingly advantageous under conditions in which wiring may be burned or otherwise destroyed to a point that the door may not be held opened under operator control. In fact, the mechanical stop of the present invention may be an improved substitute for a conventional method implemented by firefighters in which they manually prop an overhead door in an open position with a 2×4 or other beam.

A mechanical stop associated with a door opening actuator may be provided in any of a variety of combinations. For example, the mechanical stop comprising the star gear **196** and the pawl lever **216** with pawl **270** may be implemented at the end of the spring shaft similar to the embodiment shown in FIGS. **6-9**A while the micro switches may be implemented at the operator similar to the embodiment shown and described with regard to FIGS. **1-5**.

Furthermore, other types of mechanical stops may be implemented with any door opening actuator that has switches associated with the operator in accordance with the present invention. For example, a mechanical stop **282** may simply include a hook **285** rotatively mounted by a bracket **288** on a door crack **147**, as shown in FIG. **9**B. The hook **285** may be positioned to engage an axle **291** of a door roller **294** and inhibit movement of the axle and the door in a closing direction **297**. On the other hand, the hook **285** may have a ramp **300** positioned for engagement by the axle **291** when the door moves in an opening direction **303**. When the axle **291** engages the ramp **300** during opening of the door, the hook member **285** may simply be lifted by the engagement of the ramp **300** with the axle **291** and may be guided up and over the axle **291** so that the door is permitted to open. On the other hand, the door **14** may be prevented from closing when the hook member **285** is in an engaging position shown in FIG. **9**B since the hook **285** will stoppingly engage the axle **291** of the next roller **294**. The position of the hook **285** shown in FIG. **9**B is a released position that occurs during an emergency or a test situation when tension in the sash **30** has been released. Under regular operating conditions, the hook member **285** may be rotated upwardly out of the position shown. The hook member **285** may thus be rotated against the force of gravity or the bias of a spring (not shown) so that the hook member **285** reaches a position shown in dashed lines in FIG. **9**B and does not engage axles **291** of a overhead door when it is being closed and when it is being opened. As shown, the sash **30** may extend around a pulley **306** connected to the hook member **285** and the hook member **285** may be rotated out of the engaging position when the sash **30** is properly tensioned. The hook member may engage a positive stop element **309** that may be integral with the mounting bracket, for example.

FIG. **10**A is a perspective view of the test release mechanism **126** that additionally forms an anchor for one end of the sash **30** of the present invention. The release mechanism may comprise a mounting bracket **312**, which in FIG. **10**A has been rotated by 180 degrees about one axis, and rotated by 90 degrees about another perpendicular axis relative to the position shown in FIG. **6**. This reorientation demonstrates the versatility of the mounting bracket **312**. For example, fasteners **315** may be extended through holes in a narrow flange **318** and engaged in a door jam such as element **321** shown in FIG. **7**. Alternatively, the fasteners **315** may be engaged through one or both of slots **324** and **327** in a broad flange **328**. The orientation of the bracket **312** may be adjusted to fit the needs or convenience of a user or to fit with a particular wall or building structure.

The bracket **312** may be mounted on a wall or door jam at a vertical position in which the sash **30** will be taunt with a release lever **330** engaged by a tensioning catch **333**. Tolerancing may be achieved by providing the tensioning spring **129** that forms an expandably retracted section **336** in the sash **30**. When a user desires to test the system by releasing the sash **30**, he or she may grasp the release lever **330** and move it out of engagement with the tensioning catch **333** against the bias of one or more of the springs of the system and then release the lever to permit the release lever **330** to be biased with the sash **30** and rotate into a slack condition. To this end, the user may move the release lever **330** outward to clear the tensioning catch **333** and rotate the release lever **330** in a counterclockwise direction **339** upwardly to a release position and engage the release lever **330** in the release catch **342**. When proper functioning of the system has been verified, the user may return the release lever **330** to the locked position engaged with the tensioning catch **333**.

FIG. **10**B shows a front perspective view of another test release mechanism **345** in accordance with another embodiment, which may be used in place of release mechanism **126** of FIGS. **6** and **10**A. In this case, a release lever **348** may be slidably held to a door jam **321** by a bracket **351**. The sash **30** may be tensioned as described above, and the sash may be held in a tensioned state during regular use of the system by securing the release lever **348** in a retracted position by a bolt or other fastener **354** as shown in FIG. **10**B. When a user desires to test the system he or she may simply remove the fastener **354** and permit the release lever **348** to move in a protracted direction **357** that in turn releases tension in the sash **30**. After testing, the lever **348** may be returned to a

retracted position shown in FIG. **10**B and the fastener replaced to hold the lever **348** in place.

While the mechanical stop mechanism has been shown and described in specific structural detail, it is to be understood that many variations may be implemented without departing from the spirit and scope of the invention. For example, while the micro switch buttons, limit arms or spring levers, and pawl lever or switch actuator have been shown as separate components working together, it is to be understood that two or more of these components may be formed as a single component without departing from the spirit and scope of the invention. For example, a switch button could be directly connected to a sash for direct actuation. On the other hand, additional intermediate elements may be incorporated in a mechanical leakage relationship that still functions within a cause and effect actuation that is within the spirit and scope of the present invention. Also, in this regard, the switch actuator may be considered to comprise more than one of the components in the mechanical linkage relationship and or additional elements. Such configurations are considered to be within the spirit and scope of the invention as long as the mechanical cause and effect relationship of the linkage ultimately actuates the switch buttons in response to tensioning or releasing a sash that comprises or is connected to fusible links. Also within the spirit and scope of the invention is a switch actuator that may include the sash and/or fusible links.

Any mechanical stop may be used with or without the emergency door opening actuator that includes switches. However, as described with regard to the hook version of a mechanical stop, any mechanical stop may be connected to an emergency door opening actuator by the physical or mechanical linkage of a sash. As may be appreciated, the sash may comprise a chain, a cable, a wire, and/or other elements.

While the present invention has been described with regard to a spring shaft, it is to be understood that the shaft may more generally be any door lifting shaft including an actual door axle on which a door is wrapped or any shaft that is driveably engaged with a movement of the door. For example, when a star gear is engaged by a pawl to inhibit movement of a door in a closing direction, the star gear need only be fixed to a shaft that is driveably engaged with the door or that is driveably moved when the door moves. Similarly a mechanical stop of any configuration need only be stoppingly engageable with elements that are driveably moved in response to movement of the door so that stopping engagement of the mechanical stop also inhibits movement of the door.

While the systems of the present invention have been described as responsive to slack in a sash due to any emergency or test condition, and while the systems have been described as sending a signal to an existing alarm system under such emergency or test conditions, it is to be understood that the system of the present invention may also be actuated by an existing alarm system. That is, when an alarm condition is sensed by an existing alarm system, that alarm system may send a signal to the overhead door operator via one or more switches of the present invention to cause the overhead door to be opened automatically and to prevent the door from closing as has been described with regard to emergencies or tests above. Thus, the present invention may also advantageously provide an emergency door opening actuator that may be tied to an existing alarm system for greater safety in the event of an emergency sensed by the alarm system.

Several advantages are provided by the present invention. Of greatest importance, an escape route may be provided by actuation of the door in accordance with the present invention. Such actuation of the door may be caused by the emergency door opening actuator **10** of the present invention. Furthermore, entry through the garage door is one of the second most preferred modes of entry for fire fighters attempting to enter a burning house. With the present invention, the garage door will be automatically opened and locked in the opened position. Therefore, entry therethrough may be facilitated and may become the preferred mode of entry. Other advantages of the present invention may include the fact that opening the garage in accordance with the present invention may draw the fire away from other parts of the home and into the garage by feeding oxygen to the fire at the garage door.

The embodiments and examples set forth herein were presented in order to best explain the present invention and its practical application and to thereby enable those of ordinary skill in the art to make and use the invention. However, those of ordinary skill in the art will recognize that the foregoing description and examples have been presented for the purposes of illustration and example only. The description as set forth is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the teachings above without departing from the spirit and scope of the forthcoming claims. For example, while the present invention has been shown and described as formed of micro-switches and relatively large switch actuators that engage the switches, analogous circuitry may be incorporated on a circuit board or as a microcircuit. Also, the actuator has been shown and described as mounted on a particular spring shaft and associated end plate. However, it is to be understood that the actuator of the present invention may be adapted to any end bearing fixture and/or end plate. While the test release mechanism of the present invention has been described primarily as a mechanical device, it is to be understood that an analogous electrical or electromechanical device may be substituted therefor without departing from the spirit and scope of the invention.

While the actuation lever **90**, pawl lever **216**, and stop **285** are shown as being pulled in an upward direction when the sash is tensioned, it is to be understood that any one of these levers and stop may be reoriented so that tensioning the sash exerts a force in some direction than upward to accommodate the structural requirements of a building in which the respective actuators are to be installed. Alternatively, a direction changing lever may be added so that tensioning the sash applies a downwardly directed force on the direction changing lever, which in turn applies an upwardly directed force via the direction changing lever to the actuation lever **90**, pawl lever **216**, or stop **285** on an opposite side of a fulcrum of the direction changing lever. Thus, the actuator may be accommodated in buildings having very limited overhead space, for example. The direction changing lever may be of any form including a boomerang shape and may have a roller or other friction reducing mechanism for engaging an underside of the pawl lever, for example.

The release mechanism(s) of the present invention may be operatively connected to a knox box, key box, key switch, microswitch, or similar device that is mounted outside of a building for securely storing entry keys, floor plans and/or otherwise permitting access by a fire department in case of an emergency. The release mechanism(s) of the present invention may be configured to interface with any of the fire department access devices that are mounted outside so that actuation of the access device automatically releases the release mechanism and/or the sash. For example, the release mechanism may be tied into a knox box so that actuation of the knox box by the fire department automatically releases the release mechanism. The interface may be electrical and actuate the release mechanism via a solenoid. Alternatively, the interface may be mechanical or may utilize a wireless connection.

Additionally, while the present invention has been shown and described with regard to opening an overhead door in an emergency, the same principles could be used for closing doors in case of emergencies. Doing this is desirable in some applications similar to fire door applications in which isola-

tion of a fire is the goal. In this regard, the present invention has application in residential garage doors and commercial applications for both opening and closing overhead doors.

The invention claimed is:

1. A door system, comprising:

an operator operatively coupled with a door;

a first door opening actuator operatively coupled with the operator, the first door opening actuator including a switch actuator and a switch;

a first fusible link coupled with the switch actuator with a sash, wherein the switch actuator activates the switch in response to the first fusible link breaking; and

a second door opening actuator operatively coupled with the door through a shaft, the second door opening actuator including a mechanical stop operatively coupled with the shaft, and a microswitch operatively coupled with the switch.

2. The system of claim **1**, further including a pawl which operatively couples the mechanical stop with the microswitch.

3. The system of claim **2**, further including a second fusible link coupled with the pawl with the sash.

4. The system of claim **3**, wherein the pawl is biased to move from a position disengaged from the mechanical stop to a position engaged with the mechanical stop in response to the second fusible link breaking.

5. The system of claim **4**, wherein the door is restricted from closing in response to the pawl engaging the mechanical stop.

6. The system of claim **5**, wherein the switch is activated by the microswitch in response to the pawl moving from the disengaged position to the engaged position.

7. The system of claim **6**, wherein the door opens in response to activating the switch.

8. A door system, comprising:

an operator operatively coupled with a door;

first door opening actuator operatively coupled with the operator, the door opening actuator including a switch actuator and first and second switches;

a first fusible link coupled with the switch actuator with a sash, wherein the switch actuator activates the first and second switches in response to the first fusible link breaking;

a second door opening actuator operatively coupled with the door through a shaft, the second door opening actuator including a mechanical stop operatively coupled with the shaft, and a microswitch operatively coupled with the first and second switches;

a pawl which operatively couples the mechanical stop with the microswitch; and

a second fusible link coupled with the pawl with the sash.

9. The system of claim **8**, further including a spring which biases the pawl to move from a position disengaged from the mechanical stop to a position engaged with the mechanical stop in response to the second fusible link breaking.

10. The system of claim **9**, wherein the door is restricted from closing in response to the pawl moving from the disengaged position to the engaged position.

11. The system of claim **8**, wherein the first and second switches are activated by the microswitch in response to the pawl moving from the disengaged position to the engaged position.

12. The system of claim **11**, further including a push button circuit operatively coupled with the first switch, wherein the door opens and closes in response to activating and deactivating, respectively, the push button circuit.

13. The system of claim **12**, wherein the push button circuit is activated by the first switch in response to the pawl moving from the disengaged position to the engaged position.

14. The system of claim **11**, further including an obstruction sensor circuit operatively coupled with the second switch, wherein the door opens in response to activating the obstruction sensor circuit.

15. The system of claim **14**, wherein the obstruction sensor circuit is activated by the second switch in response to the pawl moving from the disengaged position to the engaged position.

16. A door system, comprising:

an operator operatively coupled with a door;

first door opening actuator operatively coupled with the operator, the first door opening actuator including a switch actuator and first and second switches;

a first fusible link coupled with the switch actuator with a sash, wherein the switch actuator activates the first and second switches in response to the first fusible link breaking;

a second door opening actuator operatively coupled with the door through a shaft, the second door opening actuator including a mechanical stop operatively coupled with the shaft, and a microswitch operatively coupled with the first and second switches;

a pawl which operatively couples the mechanical stop with the microswitch; and

a second fusible link coupled with the pawl with the sash;

wherein the first and second switches are activated by the microswitch in response to movement of the pawl.

17. The system of claim **16**, wherein the pawl is biased to move from a position disengaged from the mechanical stop to a position engaged with the mechanical stop in response to the second fusible link breaking.

18. The system of claim **16**, further including a test release device operatively coupled with the door opening actuator through the sash and a third fusible link.

19. The system of claim **18**, wherein tension in the sash is increased and decreased in response to deactivating and activating, respectively, the test release device.

20. The system of claim **16**, further including an alarm system, wherein the pawl engages the mechanical stop in response to an emergency indication from the alarm system.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,574,826 B2
APPLICATION NO. : 11/084667
DATED : August 18, 2009
INVENTOR(S) : Rob J. Evans

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

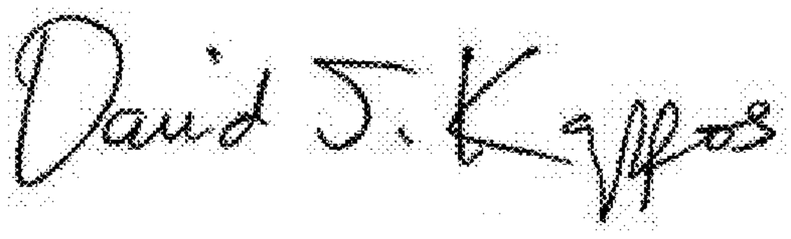
IN THE CLAIMS:

Column 15, line 28 claim 8, before "first" insert --a--.

Column 15, line 39 claim 8, before "door" insert --first--.

Column 16, line 25 claim 16, before "first" insert --a--.

Signed and Sealed this
Twenty-first Day of June, 2011



David J. Kappos
Director of the United States Patent and Trademark Office